

# Smart Water Vending Machine

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**Abstract:** Vending machines are the one which dispenses the free flowing substances such as water, oil, food, beverages etc. In order to help the public, Government had already made the facilities to provide clean drinking water with the coin based water vending machine, where on inserting a coin the system dispenses the purified water as per the need. This project uses RFID technology, the contactless technology used to identify the person or object uniquely with the help of the unique code stored in it. This technology promotes cashless transaction. Based on the unique code the person is able to vend the ample amount of water at a defined time and the amount is deducted for every use of the card. MATLAB SIMULINK is used for the analyses of speed control of the pump at the normal condition and after the feedback received from the raindrop sensor. It uses Arduino IDE and implementing it on Arduino board.

**Keywords:** RFID reader and tag, level sensor, pH sensor, Raindrop sensor, PID controller Arduino UNO, Arduino IDE.

## 1. Introduction

Vending machines are the one which dispenses free flowing substance such as water, oil, food substances, beverages etc. In order to help the public, Government had already made the facilities to provide clean drinking water with the coin based water vending machine, where on inserting a coin the system dispenses the purified water as per the need.

But controlling and monitoring of these systems has been challenging task for the operator present at the place. The person is unaware of the water level present in the tank, there might be some instances where level of the water is not sufficient to dispense the water. The purified water can be checked whether it is drinkable or not by pH value indication.

This project makes use of RFID technology to make the system cashless and uses. In order to avoid the wastage of water, we can also control the overflow of the water from the container. System make uses Arduino tools an effort is made to simplify the vending machine. This system can find applications in public places, hospitals, military camps, malls, industries etc.

## 2. Literature Review

The main aim of the literature survey is to know different methodologies, the software and hardware implementations used, in different cases. These papers include the different ideas

that are included. The main purpose is to get the knowledge applied from various reference books, conference papers, journal, and technical paper publications. These papers show the application of the vending system applied in various applications.

[1] In this paper the machines were implemented using microcontroller and FPGA. FPGA based vending machine supports fast response and use less power than microcontroller based vending machine which is coin based.

[2] This paper was proposed to deliver the paper to the public by using sensor and microcontroller based on mechatronics principle. It will be more cheap and economic for the bulk production and it will be very useful for the college and school students. Here it is designed to deliver sheets by inputting the respective coin in the system. It will help us to save more time and manual work will be modified.

[3] This paper describes the application of the vending machine to provide medication to the old age people. The user is required to press a button to get the pill.

[4] This paper proposes the coin cum cashless payment from the customer and give the desired quantity of water to be dispensed on scanning the card by user, the system detects the unique bar code of the card and deducts the amount from the card. It starts dispensing after successful deduction from the card.

## 3. Methodology

Vending machines are the one which dispenses the free flowing substances such as water, oil, beverages, snacks and many other substances.

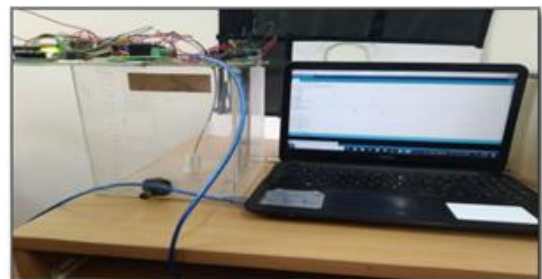


Fig. 1. Smart water vending machine

This paper describes the application of vending machine in order to dispense the water. The below figure 1 gives the experimental setup of the smart water vending machine.

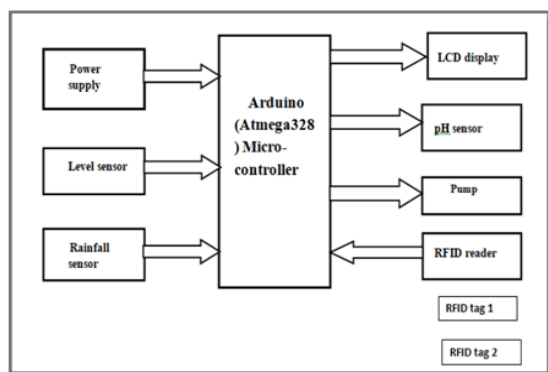


Fig. 2. Block diagram

The above figure 2 gives the block diagram of the vending machine used to dispense the water. All the components are connected to Arduino UNO which operates at 16 MHz of clock frequency and with the supply of 5v. The use of RFID technology makes the system smart. At every swipe of the tag, the defined amount of rupees 5/- is deducted from the card and the available amount is displayed. The level sensor is used to know the presence of water in the tank so that customer is able to know the availability of water in the tank to vend. It's important to check whether the water is likable to drink or no. The pH value from the pH meter gives the indication of nature of the water being acidic or alkaline in nature.

Another important objective of the system is the avoidance of overflow of water. Raindrop sensor gets high when once it comes in contact with water that is as soon as the water overflows from the container, the raindrop sensor gets high which in turn off the pump. The water is dispensed for the defined time in absence of overflow and hence the process stops.

#### A. RFID reader and tag



Fig. 3. RFID reader and tag

Radio Frequency Identification is a generic term for non-contact technology. It works on the lower frequency of 125 kHz to identify the person or object uniquely. It is compact and can be connected directly to PC using RS232 protocol. It stores the unique number that identifies a person or object that is attached to an antenna. The combined antenna and microchip are together called an "RFID tag" and work in combination with an "RFID transponder".

#### B. pH sensor

The pH sensors works on the principle that the potential difference between two electrodes gives the pH value of the solution to be found. And also the potential difference between 2 electrodes gives direct measurement of the hydrogen ion concentration or pH of the solution.



Fig. 4. pH sensor

$$pH = -\ln\{1/[H^+]\}$$

Relation between potential and pH is given by Nernst equation,

$$E = E^\circ - (RT/zF)\ln Q$$

$E^\circ$ -cell potential at standard conditions of temperature.

R-universal gas constant.

z-number of moles of electrons transferred.

F-Faraday constant (amount of charge transferred per mole of electrons).

Q-reaction quotient

$$\ln Q = \ln\{1/[H^+]\}$$

From definition of pH

$$\ln Q = -pH$$

So finally we have,  $E = E^\circ + (RT/zF)pH$

Practically voltage developed between 2 electrodes is 59.16mv per pH unit. So a pH of 4 would corresponds to voltage of 3, then the voltage from neutrality.

$$3 * 59.16 = 17.84mv.$$

The pH vs. potential difference between two probes is as shown in the figure 5.

#### C. Raindrop Sensor

Raindrop sensor is basically a board on which the nickel is coated in the form of lines. It works on the principle of resistance. When there is no rain drop on the board resistance is high so we get high voltage. When there is raindrop present on the board, it reduces the resistance, because as we know water

is the good conductor of electricity and presence of water connects the nickel lines in parallel so reduces resistance and reduce the voltage drop. This is used for controlling of overflow of water.

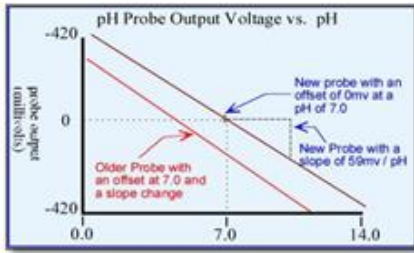


Fig. 5. pH vs. potential difference

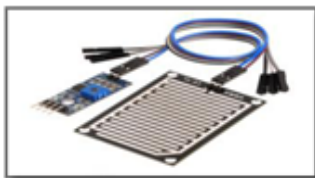


Fig. 6. Raindrop Sensor

**D. Level Sensor**

Level sensors are used to measure the level of free-flowing substances. Such substances include liquids like water, oil etc. Depending upon where the presence of the liquid is to be sensed, level sensor is used to sense at particular level of liquid. There are different liquid level sensors working on different principle such as inductive, conductive, capacitive, mechanical, magneto resistive, Hall Effect etc. The figure below shows the level sensor.



Fig. 7. Level Sensor

**E. Pump**

The working principle of a water pump depends on the type of motor- Electric, Centrifugal, Diesel driven etc. The figure shows the 5V DC water pump and it is a centrifugal pump. A centrifugal pump is powered by a device called an impeller. The impeller is a bit like a turbine. It has many curved blades, which channel the water through the pump.



Fig. 8. Pump

**F. Block diagram of PID tuning used in Simulink**

MATLAB Simulink which is used to control the Dc motor and to analyze the behavior, at the normal speed and after the feedback received by the sensor to off the pump.

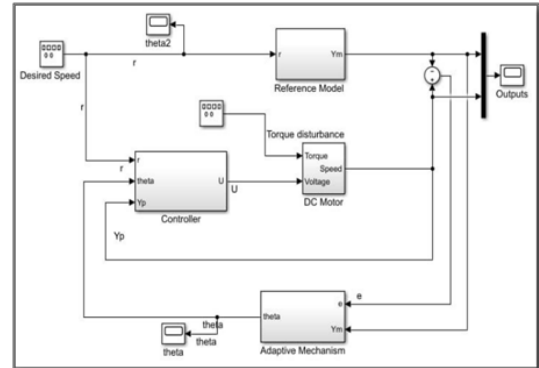


Fig. 9. Block diagram of PID tuning used in Simulink

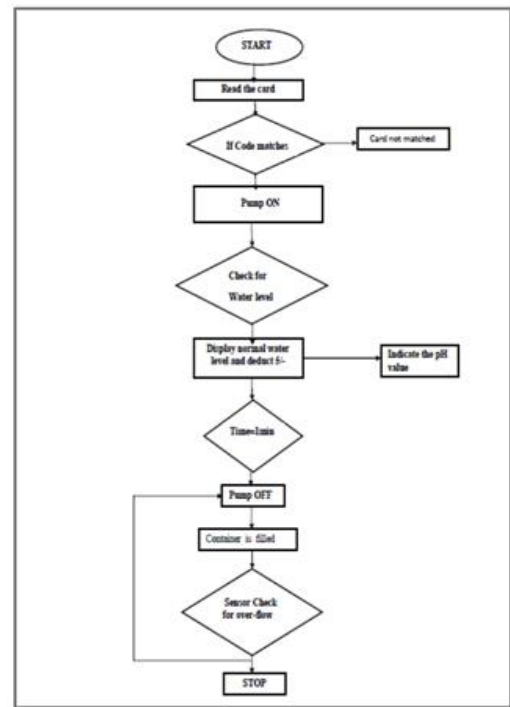


Fig. 10. Flowchart

**4. Results**

The results of the process are as shown in the figures 11, 12, 13 and 14.



Fig. 11. Initial setup



Fig. 12. Tag matched

The above two figures 11 and 12 shows the initial step of the process, if the unique code of the card matches, it displays as “TAG MATCHED” else the card is not detected by the system.



Fig. 13. Amount deducted



Fig. 14. Water quality

Once the tag is matched, the amount of rupees 5 is deducted from the card for every swipe or at every use of the tag to the reader and displays the remaining amount available in the card.

Based on the pH scale read from the pH meter, the quality of the water is displayed that is if the water quality is acidic nature, it displays as the water quality is acidic in nature by this the user can know that the water is not drinkable. While on the other hand if the water is quality is alkaline in nature, the user can know it is drinkable.

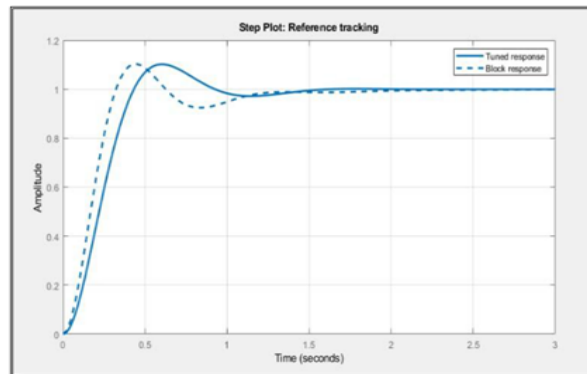


Fig. 15. PID tuning

PID controller used to tune the speed of the DC motor of the pump, the figure gives the comparison of the parameters such as the peak overshoot and the settling time of the system at the normal speed and the speed after the feedback received by the overflow sensor.

### 5. Conclusion

We developed Smart water vending system. Use of RFID technology make the system smart automated vending of water is used in many places such as public places such as: railway station, bus station, hospitals, colleges, etc. This system can be used in industries for the identification of bulk objects for exporting and importing The smart water vending system is operated in such a way that its saves both time and cost. This project concentrated on the electronics used to satisfy the objectives of the project. By the completion of project, we are able to understand the concept of cashless transaction, the controlling concepts using the sensors and feedback to the system plays a vital role in the project.

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